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Indian Standard

METHOD OF CALCULATION OF MAXIMUM EXTERNAL DIAMETER OF CABLES FOR INDOOR INSTALLATIONS

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BUREAU OF INDIAN STANDARDS
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METHOD OF CALCULATION OF MAXIMUM EXTERNAL DIAMETER OF CABLES FOR INDOOR INSTALLATIONS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 21 November 1986, after the draft finalized by the Wires and Cables for Electronic Equipment Sectional Committee had been approved by the Electronics and Telcommunication Division Council.

0.2 Overall diameter of cables is specified in a number of cable specifications. This standard has been prepared to serve as a guide to calculation of external diameter of cables.

0.3 While preparing this standard, assistance is derived from IEC Pub 649 (1979) Calculation of maximum external diameter of cables for indoor installations is issued by the International Electrotechnical Commission (IEC).

0.4 In reporting the result of a test or analyses made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard lays down a method of calculation of maximum external diameter of cables for indoor installation.

2. METHOD OF CALCULATION

2.1 Diameter of Conductor (d_c)

$$d_c = k_c \times d$$

where

d = specified nominal diameter of conductor strands

Solid:

$K_c = 1$

*Rules for rounding off numerical values (*revised*).

Stranded:

Seven strands $K_c = 3$.

More than seven strands $K_c = 1{\cdot}16\sqrt{n_1}$

(n_1 = number of strands)

The diameter d_c obtained is rounded off to the nearest 0·05 mm.

Examples:

n_1	d (mm)	d_c (mm)
16	0·20	0·95
24	0·20	1·15
32	0·20	1·30
30	0·25	1·60

2.2 Diameter of Insulated Conductor (d_i)

$$d_i = d_c + 2\,e_{im}$$

where

e_{im} = average thickness used for calculation (Table 1).

TABLE 1 RELATIONSHIP BETWEEN THE SPECIFIED MINIMUM THICKNESS AND THE AVERAGE THICKNESS OF THE INSULATION

Specified Minimum Thickness of Insulation e_i (mm)	Average Thickness of Insulation e_{im} (mm)
0·10	0·15
0·12	0·17
0·15	0·20
0·20	0·275
0·25	0·325
0·30	0·40
0·40	0·50

2.3 Increase of Diameter for Screening Individual Insulated Conductor or Elements — The increase S_1 of the diameter is as follows:

— taped screen: $3 \times n \times t_s$;

— lapped wire screen: $2 \times t_s$;

— braided wire screen: $5 \times t_s$;

— wrapping over or under screen: $n \times 0.1$ mm.

where

t_s = thickness of screen tape or diameter of screen wire

n = number of tapes

NOTE — For tapes applied without overlap: $2 \times n \times t_s$.

2.4 Diameter of Screened Insulated Conductor (d_s)

$$d_s = d_1 + S_1$$

2.5 Diameter Over Assembly — The diameter over assembly D_A is calculated from the following formula:

$D_A = K_a d_1$ (for unscreened insulated conductors).

$D_A = K_a d_s$ (for individually screened insulated conductors).

where

K_a = assembly coefficient (Table 2),

d_1 = insulated conductor diameter, and

d_s = screened insulated conductor diameter (*see* Note 2 of Table 1).

2.6 Increase of Diameter for Taping — The increase P of the diameter is as follows:

$$3 \times n \times t_p$$

where

n = number of tapes, and

t_p = thickness of protective tape.

2.7 Increase of Diameter for Collective Screen — The increase S_2 of the diameter is as follows:

— taped screen: $3 \times n \times t_s$;

— lapped wire screen: $2 \times t_s$;

— braided wire screen: $5 \times t_s$;

— wrapping over screen: $n \times 0.1$ mm.

where

n = number of tapes, and

t_s = thickness of screen tape or diameter of screen wire.

TABLE 2 ASSEMBLY COEFFICIENT (K_a)

(*Clause* 2.5)

Number of Cabling Elements (N)	Single Conductors	Pairs	Triples	Quads	Quintuples
1	1·0	2·0	2·15	2·41	2·7
2	2·0	3·4	*	*	*
3	2·15	3·65	4·1	4·9	5·6
4	2·41	4·1	4·6	5·5	6·3
5	2·7	4·6	5·2	6·2	7·0
6	3·0	5·1	6·0	6·9	7·8
7	3·0	5·1	6·0	6·9	7·8
8	3·4	5·5	6·5	7·6	8·7
9	3·6	6·0	7·0	8·3	9·4
10	4·0	6·4	7·5	8·8	10·0
>10	$1{\cdot}20\sqrt{N}$	$1{\cdot}95\sqrt{N}$	$2{\cdot}25\sqrt{N}$	$2{\cdot}70\sqrt{N}$	$3{\cdot}10\sqrt{N}$

NOTE 1 — No special coefficient has been proposed for unit cables as it is considered that the 10 percent tolerance on the maximum external diameter (*see* **2.9**) is sufficient to cover the increase in diameter which might result from this type of assembly.

NOTE 2 — For cables assembled from individually screened pairs, triples, quads or quintuples, the thickness of the screen S_1 is added, then this diameter is divided by the assembly coefficient of this element (2 for pair, 2·15 for triple, etc).

A diameter d_s is so obtained for an imaginary single conductor, this diameter will be multiplied by the assembly factor corresponding to the composition of the cable.

See example in Appendix A.

*Since these types are rarely manufactured, no coefficient is given.

2.8 Sheath Thickness — The minimum value for specified thickness e_g is given in the relevant cable specification. The value e_{gm} represents the average value to be taken into consideration for calculating the external nominal diameter (*see* Table 3).

2.9 Maximum External Diameter (D_{max}) — To obtain the maximum external diameter D_{max} of cable, the diameter over the sheath D_G is first of all calculated.

$$D_G = D_A + P + 2\,e_{gm} \text{ for cables without collective screen}$$

$$D_G = D_A + P + S_2 + 2\,e_{gm} \text{ for cables with collective screen}$$

A tolerance is added to this value: +10 percent (with minimum of 0·5 mm).

TABLE 3 RELATIONSHIP BETWEEN THE SPECIFIED MINIMUM THICKNESS AND THE AVERAGE THICKNESS OF THE SHEATH

(*Clause* 2.8)

Specified Minimum Thickness of Sheath e_g (mm)	Average Thickness of Sheath e_{gm} (mm)
0·4	0·6
0·6	0·8
0·7	0·9
0·8	1·05
0·9	1·2
1·0	1·3
1·15	1·5
1·35	1·7
1·6	2·0

This value is rounded to two decimal places, that is to say *xx.xx*.

The value is then rounded upwards to the first decimal place if the value is 5 mm or less, for example 4·61 rounded to 4·7.

If the value is greater than 5 mm, it is rounded to the first decimal place and further rounded upwards to the next multiple of 0·5 mm, examples: 25·05 rounded to 25·1 then to 25·5, 25·04 rounded to 25·0 then to 25·0.

3. TABLE OF DESIGNATIONS

3.1 The designations employed in the calculation of external diameter of cables are listed below:

d = diameter of conductor strand

d_c = conductor diameter

d_i = average diameter of insulated conductor

d_s = average diameter of screened insulated conductor

D_A = diameter over assembly

D_G = diameter over sheath

D_{max} = maximum external diameter

e_g = minimum specified thickness of sheath

e_{gm} = average thickness of sheath
e_i = minimum specified thickness of insulation
e_{im} = average thickness of insulation
K_a = assembly coefficient for cabling elements
K_c = stranding factor for stranded conductors
n_1 = number of strands of stranded conductors
n = number of tapes
N = number of cabling elements
P = diameter increase of protective taping
S_1 = diameter increase of individual screens
S_2 = diameter increase of collective screens
t_p = thickness of protective tape
t_s = thickness of screen tape or diameter of screen wire

APPENDIX A

(*Table* 2, *Note* 2)

EXAMPLE OF CALCULATION OF DIAMETER OVER ASSEMBLY FOR CABLE WITH SCREENED ELEMENTS

A-1. CABLE WITH SEVEN TRIPLES UNDER TAPED SCREEN

— conductor 32 wires 0·20 mm	$d_c = 1{\cdot}30$ mm
— specified minimum thickness of insulation	$e_i = 0{\cdot}20$ mm
— average thickness of insulation	$e_{im} = 0{\cdot}275$ mm
— diameter of insulated conductor	$d_i = 1{\cdot}30 + (2 \times 0{\cdot}275)$ $= 1{\cdot}85$ mm
— diameter of triple	$1{\cdot}85 \times 2{\cdot}15$ $= 3{\cdot}98$ mm
— thickness of screen tape	$t_s = 0{\cdot}05$ mm
— diameter of the screened triple	$3{\cdot}98 + (0{\cdot}05 \times 3)$ $= 4{\cdot}13$ mm
— diameter of an imaginary single conductor	$4{\cdot}13 : 2{\cdot}15\ d_s$ $= 1{\cdot}92$ mm

A-2. DIAMETER OVER ASSEMBLY D_A (SEVEN TRIPLES)

$$K_a = 6{\cdot}0$$

$$D_A = 1{\cdot}92 \times 6{\cdot}0 = 11{\cdot}52 \text{ mm}$$